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Attn: Mr. G.F. Smith

MANITOU FALLS GS
INSTRUMENTATION INSTALLATION 1990

C.B.H. Cragg

A pendulum and three survey monuments were installed at Manitou Falls GS in September, 1990 to monitor the deformation behaviour of this concrete gravity dam. The installation of these devices and initial readings are described in this report.

1.0 INTRODUCTION

Manitou Falls GS is a 69 foot high by 1100 foot long concrete gravity dam and earth wing dam structure located on the English River north of Dryden, Ontario. Some structural distress has been observed in the powerhouse which abuts the main concrete dam. As the first step in installing an alignment survey on the crest of the structure, 8 brass plugs were installed in late 1989 (Figure 1). Off-dam survey monuments and an inverse pendulum were requested to complete the deformation monitoring instrumentation for the concrete gravity dam. These instruments were installed in September, 1990. A description of these installations and initial readings is contained in this report.

2.0 PENDULUM

The purpose of pendulums is to monitor (a) horizontal movement of the crest of the dam relative to the base of the dam and (b) horizontal movement of the base of the dam relative to its underlying rock foundation. In most dams, a normal and an inverse pendulum are required to accomplish this purpose. In this dam, a stairwell from the generator floor (elevation 1102 feet) to the headworks (elevation 1140 feet) in the erection bay (Figure 1) allowed this function to be achieved with an extended inverse pendulum. Due to the

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presence of an electrical room below the stairwell, the inverse pendulum was drilled from the first stair landing (elevation 1108 ft) to a depth of 69.5 feet. Holes were cut in the intermediate and top landings to allow the pendulum and extensometer wires to pass upward to the support table on the dam crest (elevation 1140 ft) as shown in Figure 2. Swiss co-ordiscope reading tables were installed at the 1108 ft and 1140 ft levels (Figures 3 and 4). Floor mounted supports were used for these tables to ensure that they moved in concert with the main dam concrete. The conventional wall mount brackets were not suitable in this case because the stairwell is separated from the main dam by a partition wall and a 6 inch air space (Figure 2).

Figure 5 shows a record of the 3 inch diameter (NQ) inverse core hole alignment during drilling and the depths at which realigning corrections were made. The Hydro-Quebec drilling system was used for this work. Bedrock was encountered at a depth of 20 feet 4 inches (approximately elevation 1087.3). Frequent alignment corrections were necessary in the bedrock due to the steeply dipping bedding. A Huggenberger optical co-ordiscope was purchased to read the pendulum and has been left in the custody of the Ear Falls regional staff. Initial readings on the pendulum tables are given in Table I. Autocentering readings, taken at 5 foot depth intervals, are recorded in Table II.

3.0 SURVEY MONUMENTS

Three survey monuments equipped with forced centering plates were installed at locations shown on Figure 1. The two monuments in line with the dam were constructed in soil using a pad and pier design. A backhoe was used to excavate the bouldery soil to found the spread footing about 7 feet below grade. The 18 inch diameter pier extended from the footing to about 4 feet above grade (Figure 6). One of these piers is not plumb as a result of the bracing shifting during pouring. A short (16 inch high) rock anchored pier was constructed upstream of the dam as the third monument. Initial surveys on these monuments and the brass plug alignment stations will be carried out by the Civil Maintenance Department.

4.0 SUMMARY

The construction of survey monuments and a pendulum at Manitou Falls GS have been documented for future reference along with initial pendulum readings.

ACKNOWLEDGMENTS

Construction of these instruments was arranged and carried out by A. Morton with D. Fraser and B. Mackey of the Soil Sciences Section, and B. Williams of the Rock Sciences Section (field drilling). R. Dowdell contributed significantly to the mobilization and

coordination of resources. Ear Falls regional staff assisted with excavation and monument construction.

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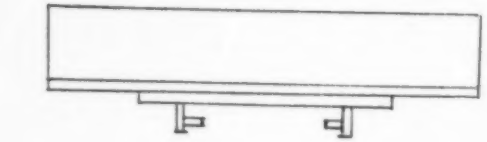
TABLE I MANITOU FALLS GS
INVERSE PENDULUM

Initial Readings (inches)
Machinist Convention---
Upstream is NORTH

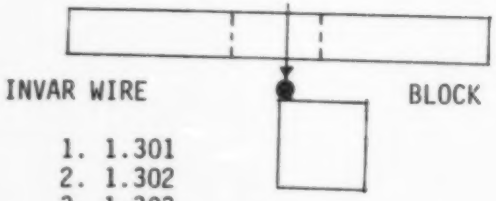
Date: Sept.27/90
Read by: A.Morton

1108 ELEVATION



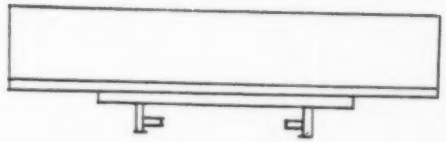
Microlevel
E/W FS +0.18
N/S FW +0.18

N/S	E/W
1. 1.770	1. 3.192
2. 1.7695	2. 3.1915
3. 1.7695	3. 3.1925



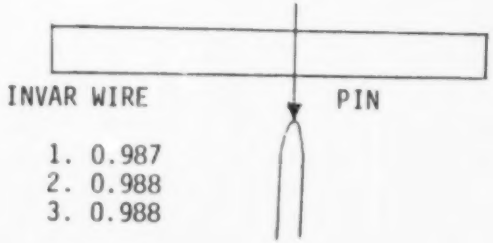
1. 1.301
2. 1.302
3. 1.303

1140 ELEVATION



Microlevel
E/W FS -0.39
N/S FW +0.48

N/S	E/W
1. 0.8885	1. 3.2495
2. 0.8885	2. 3.2485
3. 0.8895	3. 3.249



1. 0.987
2. 0.988
3. 0.988

CALIBRATION BLOCK

N/S	0.285	0.2855
E/W	3.7645	3.7645

TABLE II

Manitou Falls GS
Auto Centering Readings on Inverse Pendulum - Sept 27/90
at 1108 foot Elevation*

DEPTH (ft)	NORTH/SOUTH READING (inch)		EAST/WEST READING (inch)	
	Set #1	Set #2	Set #1	Set #2
INITIAL	1.770		3.195	
0	1.797	1.790	3.035	3.032
5	1.638	2.636	3.063	3.061
10	1.565	1.567	3.012	3.015
15	1.548	1.544	2.958	2.959
20	1.545	1.543	2.939	2.939
25	1.567	1.562	2.882	2.877
30	1.612	1.613	2.794	2.798
35	1.691	1.689	2.767	2.771
40	1.738	1.747	2.723	2.729
45	1.769	1.772	2.720	2.720
50	1.863	1.869	2.802	2.812
55	1.900	1.895	2.921	2.921
60	1.855	1.859	3.017	3.009
65	1.790	1.788	3.145	3.148
FINAL	1.767		3.192	

*All depth readings refer to top of casing 4" above floor level.
Tape plus 2 ft leader equals depth.

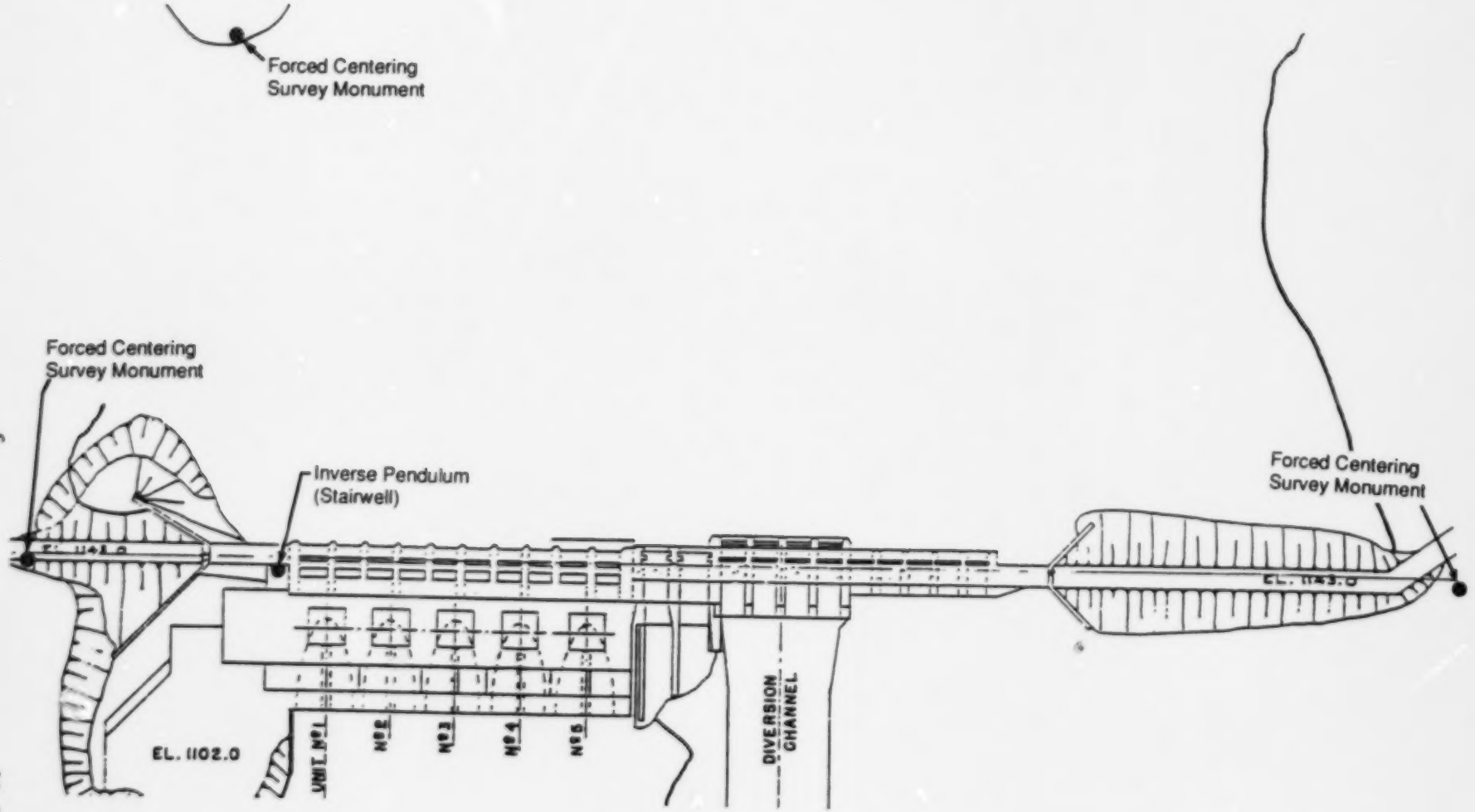


FIGURE 1

MANITOU FALLS G.S.
PLAN OF INSTRUMENT LOCATIONS

90-354 185227 RD-AF41

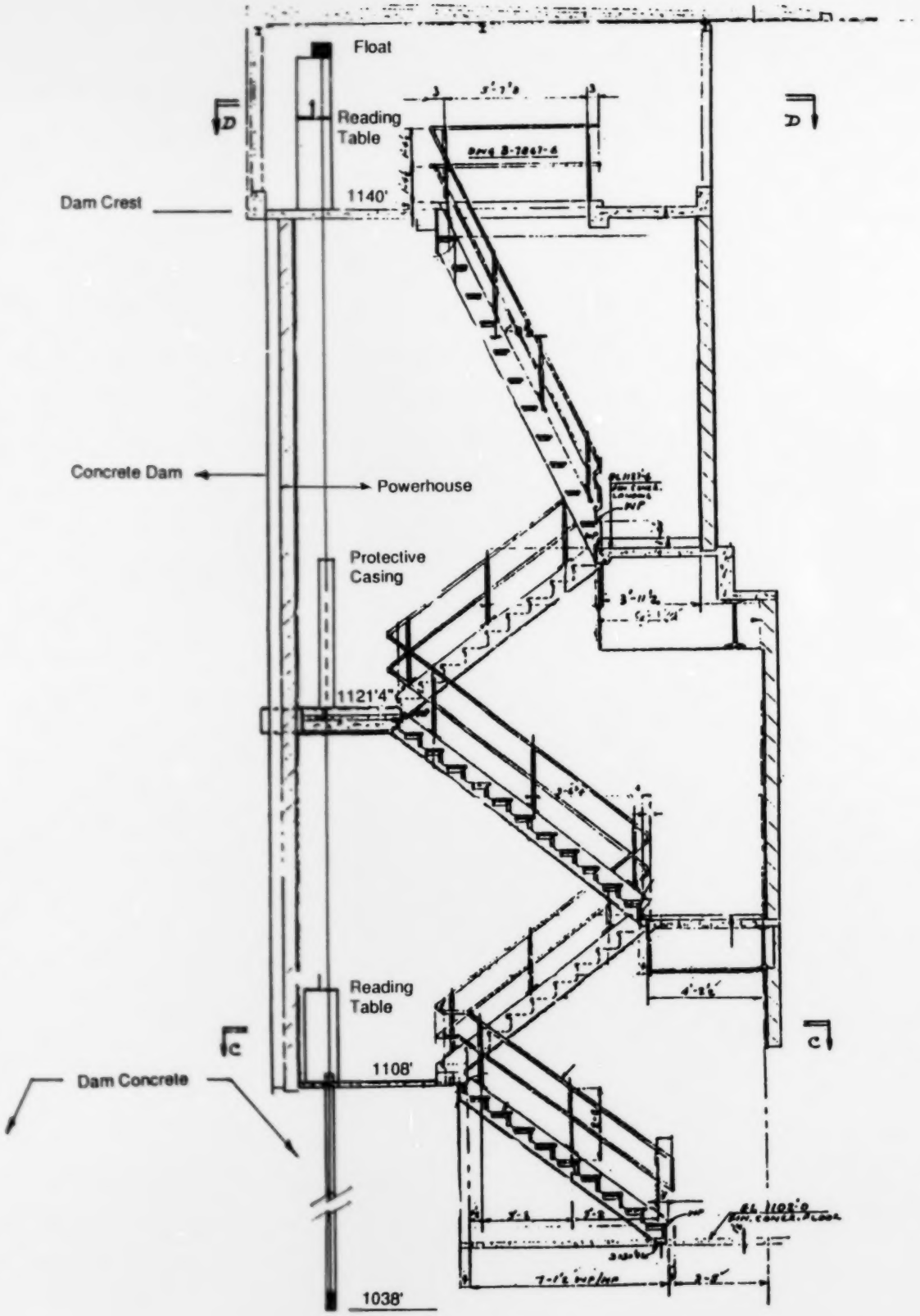


FIGURE 2

CROSS SECTION OF INVERSE PENDULUM AT MANITOU FALLS G.S. STAIRWELL

185228 RD-AF41

90-354

FIGURE 3

FLOAT AND READING TABLE ASSEMBLY
FOR INVERSE PENDULUM AT MANITOU FALLS
(ELEVATION 1140')

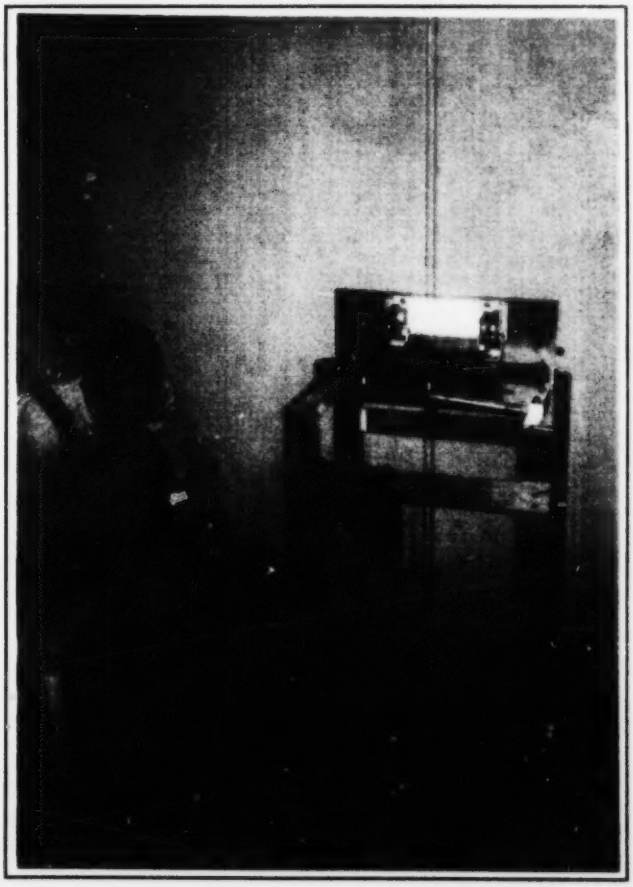


FIGURE 4

READING TABLE FOR INVERSE PENDULUM
AT MANITOU FALLS
(ELEVATION 1108')

90-354
185224 RD-AF41

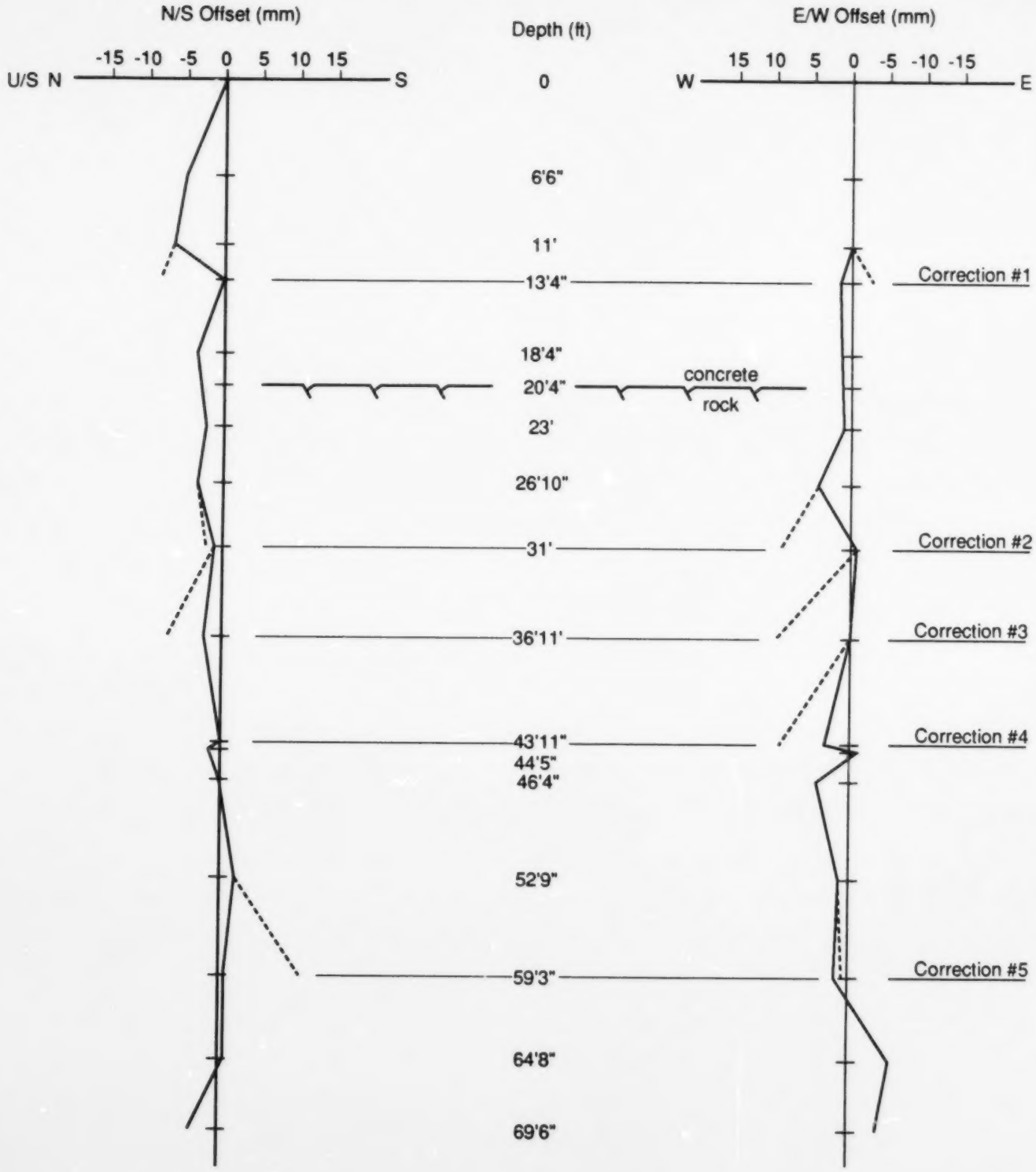


FIGURE 5

MANITOU FALLS G.S.
INVERSE PENDULUM PROFILE

185225 RD-AF41